

eKOR

EUROTECH

Corporate Background

EUROTECH, Ltd. is a leader in the development of emerging chemical and environmental technologies. The Company works with scientists, engineers and research institutes to identify and commercialize products and processes whose unique or superior characteristics have the potential to create high commercial value. A U.S.-based company, Eurotech has assembled a portfolio of products that have widespread market applications.

EKOR™, a family of advanced materials for nuclear and hazardous waste containment, is the first technology that Eurotech has brought to market. EKOR is an advanced silicone polymer composite that is the most effective means of preventing radioactive contaminants from spreading.

Brief History of EKOR™

EKOR was created by a team of nuclear scientists from the I.V. Kurchatov Research Center and the EuroAsian Physical Society to specifically address the problems resulting from the nuclear accident of Reactor 4 at Chernobyl, Ukraine in 1986. As EKOR neared the final stages of development in 1995, EUROTECH, Ltd. was formed to provide the support necessary to complete this important project.

After years of performance testing verified the radiation-resistance properties of EKOR, Eurotech adopted a simple three-step strategy to commercialize EKOR - first, apply EKOR at Chernobyl in the application for which it was created; second, transfer the EKOR technology to the U.S. for production and use in a variety of nuclear and hazardous waste remediation projects; and third, make EKOR available for worldwide waste management.

EKOR is the only long-term encapsulant certified by the Ukrainian government and applied at Chernobyl's failed Reactor 4.

EKOR™ Application at Chernobyl



EKOR is the only product to successfully encapsulate one of Chernobyl's most critical radioactive fuel containing masses.



Applied in March 2000 to one of the most critical fuel-containing mass at Chernobyl, EKOR is demonstrating its superior encapsulation properties in a high radiation environment.

U.S.-produced EKOR has undergone a rigorous testing program to confirm its unique performance properties under conditions in which other materials could not endure. Independent laboratories working to NQA-1 standards have confirmed its superior performance in leach-resistance (more than twice the NRC standard), chemical-resistance, adhesion, permeability, outgassing (no hydrogen), aging, fire-resistance and non-toxicity. Several EKOR forms are currently being successfully demonstrated at DOE sites.

EKOR™ SILICONE-BASED GEOPOLYMERS

The EKOR family of Geopolymers employs a revolutionary silicone block copolymer as the key building block of its individual forms. This polymer base was created to have exceptional radiation and chemical resistance. The addition of selected fillers and catalysts creates unique forms that can be pumped, poured or sprayed and are adaptable to individual project requirements.

EKOR products and services have been developed under a Quality Assurance Plan that meets the requirements of NQA-1. Each formulation has completed or is in the process of completing performance testing conducted by certified independent laboratories.

The distinctive properties of block copolymers give EKOR materials performance benefits over other polymer and encapsulation technologies. Other fixatives and foams are available for short-term use, but no other product can match the combined durability, ease of use and strength of EKOR for in-situ stabilization or storage. EKOR is able to solidify a variety of low and high level liquid and mixed waste streams and associated corrosive chemicals.

EKOR applications range from in-situ stabilization, D & D, containment and encapsulation to transportation and final storage and disposal. EKOR™ can also assist in resolving the special challenges faced by operating reactors in nuclear power plants and research facilities, uranium/thorium and other mining venues, nuclear medicine and the chemical industry.

The EKOR™ Advantage

◆ Highly Radiation-Resistant

The EKOR family of products has undergone radiation-resistance testing to an accumulated dosage of 10 billion rads. No other material on the market has successfully undergone such extensive radiation testing. EKOR is nuclear safe and does not become radioactive after exposure. If EKOR has not been in direct contact with a radioactive material, it may be disposed as municipal waste.

◆ Low Out-Gassing

Even when exposed to radiation, EKOR materials have very low out-gassing emissions, approaching those of Portland cement, and do not present a fire or explosion hazard.

◆ Fire-Resistance

EKOR products are proven to be highly resistant to ignition and flame spread and develop little smoke.

◆ Resistance to Environmental Aging

EKOR is long-lasting and extremely resistant to degradation caused by challenging environmental conditions. Even in corrosive alkaline or acidic conditions or chemically aggressive environments, EKOR remains structurally intact.

◆ Non-Toxic

In both its applied and cured forms, EKOR is a non-toxic material.

◆ High Surface Adhesion

EKOR adheres to almost anything, including rusty, corroded and wet surfaces, and will cure underwater.

◆ Effective Barrier

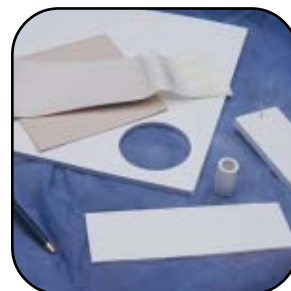
This family of products has very low permeability and no detectable leachability.

EKOR™ Products

Eurotech can supply EKOR as a coating or sealing agent with varying viscosity and as flexible or rigid foam. EKOR properties are easily customized to meet customer requirements and constraints.

EKOR™ Sealer

EKOR Sealer is used as a macroencapsulant to coat large or small containers or to repair corroded drums or boxes. This formulation is applied by brush or sprayer and can penetrate cracks and crevices greater than 1 mm. It will solidify on surfaces up to 120° C. Sealer can be used to repair spent fuel pools and seal parts that are stored underwater.



EKOR™ Coating

EKOR Coating effectively isolates contaminated facilities and equipment surfaces when applied with a brush or sprayer. It functions as a provisional seal and may be used on units that will later be reactivated or further decommissioned.

EKOR™ Foam

EKOR Foam isolates and contains loose contaminants in hard to access areas such as ducts and pipes. The density of the foam can be modified to achieve individual site objectives.



EKOR™ Grout & Matrix

EKOR Grout is applied in a “pour and mix” fashion to microencapsulate assorted dry wastes, including metal components, sorbents and resins. Grout produces an unleachable monolith for transportation and disposal when mixed with dust, ashes, salts and other fine solids in a 1:4-1:6 ratio.

EKOR Matrix is used with high and low level liquid wastes and some dry wastes. The versatile EKOR Matrix is also applied by a “pour and mix” method. Liquid solutions and slurries containing sediments and other fine solids can be combined with EKOR Matrix in a 1:1 ratio

EKOR™ Services

Eurotech's engineers, project managers and quality technicians support the successful application of EKOR products. In addition, Eurotech has formed strategic partnerships with other industry leaders to guarantee customer satisfaction.

Eurotech has partnered with Florida International University's Hemispheric Center for Environmental Technology (HCET) to formalize and test application procedures, develop training methods, and establish and monitor an applicator certification program.

HCET was chosen by the U.S. Department of Energy to facilitate technology integration into remediation and waste management programs.

Eurotech can customize product forms and application services to meet the needs of specific nuclear waste applications. Eurotech currently offers the basic services summarized below.

◆ Application Equipment

Eurotech's engineers work with HCET to ensure that the EKOR equipment specifications and application procedures are consistent with U.S. nuclear standards and practices.

◆ Training

EKOR products must be applied by certified applications technicians. HCET has developed and codified the training procedures required for field application and will certify companies and personnel upon completion of the formal applicator certification program.

◆ Project Management

Eurotech works with vendors, suppliers and contractors to meet site-specific project requirements. Eurotech serves as a liaison between its customers and partners to facilitate timely delivery of both EKOR products and applications equipment.

◆ Engineering Support

Engineering services, conducted under a Quality Assurance Plan that meets the requirements of NQA-1, include providing technical support to waste managers and waste management contractors for EKOR application equipment fabrication, mixing and application. Services also include post-application inspections and testing.

Production Facilities



Eurotech's manufacturing partner for production of EKOR is NuSil Silicone Technology, a leading supplier of silicones to the aerospace and healthcare industries that is headquartered in Carpinteria, California, with European operations in Anglet, France. NuSil is an ISO 9001 certified company with over 250 employees and an extensive worldwide customer base.



EKOR™ Sealer Product Testing Data

Overview

Coupons of U.S.-produced EKO Sealer were subjected to a series of tests designed to illustrate its performance under a wide variety of environments. The tests were performed by independent certified laboratories under a Quality Assurance program approved by the Nuclear Regulatory Commission. Following is a summary of key parts of the test results.

Product Performance Testing

1. Chemical Resistance (ASTM D 3912)

In this test three coupons were placed in each of twenty separate chemical solutions (60 coupons total) for a duration of 30 days each. The solutions and their pH were: N₂H₄ (9.47), Borax (9.15), deionized water (7.93), Boric acid (5.31), Sulfuric acid (1.25), H₂O₂ (2.74), Na₃PO₄ (10.71), Aluminum Sulfate (3.14), Calcium Nitrate (6.12), CrCl₂ (2.94), FeCl₂ (2.07), MnSO₄ (7.15), NaOH (11.21), Pb(NO₃)₂ (5.37), Si₂Cl₄ (0.36), Na₂CO₃ (10.43), NaNO₂ (8.54), ZrSO₄ (1.04), K₃PO₄ (13.84) and NH₄F (7.34). All sixty coupons were completely intact at the conclusion of the test with no peeling, delamination or blistering.

2. Permeability (ASTM E 96)

The average water vapor transmission (WVT) rate of three coupons was 3.9 g/m²/24 hrs, well under the most stringent requirements.

3. Adhesion (ASTM 3359)

All six coupons met criteria for 5A rating, the best possible, with no peeling or removal of material.

4. Weathering (ASTM G 26)

All samples easily passed with either a 4.5 or 5 on the 5-point scale. The 4.5 indicated slight discoloration but no material deterioration.

5. Salt Spray (ASTM B 117)

The test coupons showed no blistering, delamination or evidence of corrosion.

6. Ignitability (ASTM D 2863)

None of the EKOR Sealer coupons charred at less than 31% oxygen and there was no ignition.

7. Leachability (ANS 16.1)

Three coupons were tested with each of three aqueous solutions of cesium, cobalt and strontium salts. There was no detectable leaching of any of the salts.

8. Aging

Several coupons were thermally treated over a range of temperatures and times to establish a mass loss relationship that could be correlated to natural aging. Using a process developed by the Kurchatov Institute of Russia and approved by the American Polymer Institute, coupons were then thermally conditioned to a predicted age of 171 years. The aged coupons were then subjected to chemical resistance, tensile/elongation and adhesion tests. The chemical resistance test was per ASTM D3912 again, but with only the NaOH solution; the coupons showed negligible coating surface deterioration, with no peeling or blistering. The tensile/elongation

test showed an increase in strength to an average of 332 psi and a decrease in elongation to an average of 97%. The adhesion results were a rating of 5A, the highest, with no peeling or removal of material. Taken in total, the aged coupons showed a continued excellent resistance to chemical attack, a great elasticity and tremendous adhesive capability.

9. Flame Spread (ASTM E 84)

The flame spread index was 15 and the smoke development value was 275, both well under criteria for indoor application.

Product Definition Testing

1. Linear Shrinkage/Coefficient of Thermal Expansion (ASTM C 351)

The average of four specimens was 1.30% linear shrinkage and 0.0002 in/in/oF.

2. Steady State Heat Flux

The average of three specimens was 0.265 Btu/hr ft oF.

3. Volatile Organic Content

The tested value was 36 g/l, well under most site requirements of 350 g/l. No toxic or explosive gasses were measured.

4. Tensile Strength/Elongation (ASTM D 412)

The average tensile strength was 201 psi and elongation was 176%. These values show excellent elastomeric behavior.

5. Compressive Strength (ASTM D 695)

The five coupons had an average compressive strength of 911 psi at yield and an average compressive modulus of 2918 psi.

6. Water Absorption (ASTM D 570)

The average of five coupons was 0.4% by weight, significantly less than most elastomers.

Conclusions

These results combine with previous test and demonstration data from Russia to show that EKOR Sealer has unique properties:

- ◆ Very High Resistance to Degradation due to Irradiation (Tested to 10 Gigarads without deterioration)
- ◆ Very High Resistance to Degradation due to Aging
- ◆ Very High Resistance to Degradation due to Chemical Exposure
- ◆ Very Low Permeability
- ◆ No Measurable Leachability
- ◆ No Toxic Components
- ◆ Fire-Resistant and able to withstand transient temperature spikes to 1100°F
- ◆ Extremely Adhesive to practically any Surface, even Rusty, Dirty, Wet or Underwater Environments

These properties make EKOR Sealer ideal for providing a stable environmental barrier inside OR outside of containers, including patching leaks. EKOR Sealer is also an ideal macroencapsulant and is a stable waste form being submitted for approval to existing disposal site.

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